# REVIEWS

*The Problem of the St. Peter Sandstone.* By CHARLES LAURENCE DAKE. Bulletin of School of Mines and Metallurgy, University of Missouri, Vol. 6, No. 1. Rolla, 1921. Pp. 228, pls. 30.

Professor Dake finds the St. Peter sandstone in Minnesota and Wisconsin equivalent to the upper part of the Chazy, and in Oklahoma and Arkansas, to all of it. It is unconformable with the Potsdam sandstone in Wisconsin, and with strata above the Potsdam farther south, up to the Arbuckle limestone in Oklahoma.

A study of the characteristics of the sandstone, such as composition, texture, and structural features was undertaken with a view to determining the origin of the sand. The author appears to have started with hospitable attitude toward the hypothesis that the sand is of eolian origin, but in the end he was led to the conclusion that several of the criteria usually held to indicate an eolian origin for sand (1) are "of less positive significance than is generally believed"; that (2) they are "significant only of conditions of transportation, and not of deposition"; that (3) they are "sometimes inherited from an older formation"; and that (4) they are "not present in the St. Peter in any appreciably greater perfection than in other sandstones of the same region known to be marine." He also holds that structural features imposed on a formation at the time it is laid down are "the only positive criteria as to conditions of deposition. These criteria point rather definitely to the marine origin of the [St. Peter] formation."

Of special significance in this connection is the basal conglomerate present in many places, for in it there is "no sign of wind polish or of faceted forms, and nothing comparable to desert varnish" (p. 187).

This conclusion as to the origin of the St. Peter sandstone is not only interesting in itself, but seems to suggest that the "continental deposition" idea, long neglected, has of late been overworked. In sundry recent publications it has almost seemed that if a marine origin for a formation is not proved, a non-marine origin is assumed. This volume is a wholesome check to this tendency.

Some of the author's detailed conclusions are as follows:

1. The composition and texture of a sandstone may furnish criteria regarding its derivation and transportation, but not regarding its method of deposition.

2. The history of the sand grains of a sandstone is usually so complex, including transportation successively by winds, streams, and waves, that textural criteria afford no proof whatever of the nature of transportation, even to the *last deposit in which the sand is found.* . . . .

3. The structural and stratigraphic relationships in the field, including such features as the character of bedding, cross-bedding, unconformities, lateral gradation and similar associated phenomena, constitute the only valid criteria for determining the conditions under which a deposit was last laid down, and these may sometimes give a clue to the method of transportation *to that particular resting place.*

4. The purity of the St. Peter sandstone, while very remarkable, as compared with that of average sandstones, is . . . . not sufficiently different from that of associated marine sandstones to demand any essentially different explanation of origin; . . . .

5. Size of train, *in pure quartz sands*, in general, is limited by the size of quartz grains in average igneous rocks, and is not a satisfactory criterion of wind-blown sands.

6. The size and uniformity of grain in the St. Peter is so near that of the Roubidoux marine sand, that no discriminations as to origin can be made on such a basis.

7. The degree of rounding and frosting of grains, which has been used as one of the chief arguments for eolian origin of the St. Peter, may often be masked by secondary quartz enlargement, but making due allowance for such modification, the St. Peter cannot be distinguished, on this basis, from the marine Roubidoux, or from older Cambrian sandstones. . . . .

8. The St. Peter shows bedding better developed than cross-bedding, and does not show typically developed dune-structure, even in the protected basal layers in the valleys of the old erosion surface. . . . .

11. Limestone layers occur at many horizons, particularly at the south, but are known as far north as north central Iowa and northern Illinois, and indicate marine deposition.

12. Oscillation ripple-marks in sand layers, marine fossils in limestone beds . . . . occur in Arkansas and Missouri, next above the unconformity [at the base of the series], showing submergence before the advance of the sand into the region.

13. Marine fossils are found in the St. Peter as far north as Minneapolis, not only in the uppermost transition layers, but also at three horizons, more than 60 feet below the top. These would not appear to have resulted from working over of dune deposits.

14–19. The St. Peter appears to have been derived from a relatively low land mass to the northward. This land is believed to have sloped southward, in which direction its rivers flowed, to have been affected by a moderately humid climate, but not to have been clothed with vegetation, because land plants had not yet developed. The land included pre-Cambrian crystalline rocks and a broad fringe of Potsdam sandstone.

20. The derivation of the St. Peter, largely from this Potsdam belt in which the sands were already well assorted and rounded, together with the added sorting and rounding by wind work in the supply area, and by waves in the sea, explains in a wholly satisfactory manner the high degree of purity and rounding of its grains.

21. These sands were delivered to the sea both by rivers and to a minor degree directly by winds, and were distributed chiefly by waves and currents.

22. The shores of this sea were fluctuating, but during middle and late St. Peter time, were for the most part north of the Iowa-Minnesota line.

23. North of that line there is quite probably a small amount of St. Peter that is truly unmodified terrestrial deposit. . . .

24. South of the Iowa-Minnesota line, conditions of both transportation and deposition were almost wholly marine, and in this area there did not exist during any part of St. Peter time, a great interior desert of drifting sand.

A discussion of the geographic conditions under which this and other early Proterozoic formations were made, closes the volume.

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*Deposits of Manganese Ore in Arizona.* By E. L. JONES, JR., and F. L. RANSOME. Bulletin 710-D, United States Geological Survey, Government Printing Office, Washington, D.C., 1920. Pp. 92, pls. 6, figs. 8.

The production of manganese ore as such in Arizona dates from 1915. The producing district lies in the more southern part of the state. The greater part of the ore worked bears at least 35 per cent manganese, and not more than 4 per cent iron. The ore is shipped east to Illinois, Alabama, Tennessee, and Pennsylvania, and lately also to California. Perhaps the chief difficulty encountered in production lies in the inaccessibility of the mines to railroads, which necessitates "packing" the manganese out of the mining district, a tedious and expensive process.

Various scattered manganese have been studied by Mr. Jones in the preparation of this paper. Dr. Ransome describes those at Bisbee and Tombstone. In the latter district, the sequence extends from the pre-Cambrian Pinal schist through Cambrian, Devonian, Mississippian,